1913

Willis Chipman

Reprinted from The Journal
of the Royal Astronomical Society of Canada,
September-October, 1913.

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THE BOUNDARY SURVEY BETWEEN CANADA AND THE UNITED STATES EAST OF THE ST. LAWRENCE RIVER

BY

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By Thomas Fawcett

UNDER terms of a treaty between Her Majesty the Queen of the United Kingdom of Great Britain and Ireland, signed at Washington, August 19th, 1842, by the Right Honorable Alexander Lord Ashburton for Her Britannic Majesty and Daniel Webster, Secretary of State, for the United States.

Article 1 which covers that part of the boundary considered in this paper reads as follows :—

" It is hereby agreed and declared, that the line of boundary shall be as follows :—Beginning at the monument at the source of the River St. Croix, as designated and agreed to by the Comissioners under the Fifth Article of the Treaty 1749 between the Governments of Great Britain and the United States ; thence north, following the exploring line run and marked by the Surveyors of the two Governments in the years 1817 and 1818 under the Fifth Article of the Treaty of Ghent, to its intersection with the River St. John, and to the middle of the channel thereof ; thence up the middle of the main channel of the said River St. John to the mouth of the River St. Francis ; thence up the middle of the channel of the said River St. Francis and of the lakes through which it flows, to the outlet of the Lake Pohenagamook ; thence south westerly in a straight line, to a point on the north west branch of the River St. John which point shall be ten miles distant from the main branch of the St. John in a straight line and in the nearest direction ; but if the said point shall be found to be less than seven miles from the nearest point of the summit or crest of the highlands that divide those rivers which empty themselves into the St. Lawrence from those which fall into the River St. John, then the said point shall be made to recede down the said north west branch of the River St. John to a point seven miles in a straight line from the said summit or crest; thence in a straight line in a course about south eight degrees west to the point where the parallel of latitude 46° 25′ north intersects the south west branch of the St. John; thence southerly by the said branch to the source thereof in the highlands at Metjarmette Portage; thence down along the said highlands which divide the waters which empty themselves into the St. Lawrence from those which fall into the Atlantic Ocean, to the head of Hall's Stream; thence down the middle of said stream, till the line intersects the old line of boundary surveyed and marked by Valentine and Collins previous to the year 1774 as the 45th degree of north latitude, and which has been known and understood to be the line of actual division between the State of New York and Vermont on one side and the British Province of Canada on the other; and from said point of intersection west along the said dividing line as heretofore known and understood, to the Iroquois or St. Lawrence River."

Article No. 6 of the same Treaty made provision for carrying the terms of the treaty into effect by appointing two Commissioners, one by Her Britannic Majesty and one by the President of the United States and the Senate thereof. A section of the Article reads as follows:—

"The said Commissioners shall meet at Bangor, in the State of Maine, on the 1st of May next, or as soon thereafter as may be and shall proceed to mark the line above described from the source of the St. Croix to the River St. John, and shall trace on proper maps the dividing line along said river and along the River St. Francis to the outlet of Lake Pohenagamook; and from the outlet of the said lake, they shall ascertain, fix, and mark by proper and durable monuments on the land the line described in the first article of this treaty; and the said Commissioners shall make to each of their respective Governments a joint report or declaration under their hands and seals, designating such line of boundary, and shall accompany such report or declaration with maps, certified by them to be true maps of the new boundary."

The Commissioners appointed by the two Countries were Lieut. Col. J. S. Buchnal Estcourt on behalf of Her Britannic Majesty and Mr Albert Smith for the United States. With a view to carrying out the necessary astronomical work which such a survey demanded, on behalf of Her Majesty's Government, the Earl of Aberdeen, then Secretary of State for the Foreign Department, applied to Professor G. B. Airy, F.R.S., the Astronomer Royal, requesting him to recommend two practical astronomers accustomed to the use of first class instruments since it would be necessary to determine with accuracy the latitudes and longitudes of several points for the purpose of determining the positions denoted in the Treaty. After studying the wording of the Treaty, Professor Airy submitted several questions to the Foreign Office in reference to the wording of certain clauses which he considered required a more definite meaning before he would be prepared to lay out any scheme for the Astronomical Work. The questions by Mr. Airy and replies thereto given by Mr. H. M. Addington, Secretary to the Foreign Office are as follows: The questions refer to the wording of certain sections of the Treaty.

Question I.

"Thence north, following the exploratory line run and marked by the surveyors, etc." Is this line to be traced truly north, even though it diverge from that of the former surveyor; or is any respect whatever to be paid to the line of the former surveyors?

Answer.

The line of the former surveyors is intended to be adhered to, consequently the term "north" does not mean truly north, but in a northerly direction.

Question II.

"Thence southwesterly in a straight line to a point on the north west branch of the St. John, which point shall be ten miles distant from the main branch of the St. John." Is the line to be traced truly south-west? the point upon the north-west branch of the St. John is a strictly definite point and may not be hit by a southwesterly line,—and does the expression ten miles denote ten miles at the least?

Answer.

The term ten miles denotes ten miles at least, according to the English view of the Treaty; consequently the term *southwest* must be taken as meaning not truly southwest but in a southwesterly direction.

Question III.—Last line but two.

"And from said point of intersection west along the said dividing or heretofore known and understood." The doubt is the same as in question No. 1. If the new line diverge from the old understood line, which is to be adopted?

Answer.

The old line is to be adhered to, consequently the term west must be taken as meaning westerly direction."

After receiving those answers Professor Airy compiled a table containing a summary of such observations as he thought would conform with the requirement as set forth in the several answers to the questions submitted.

SECTION OF BOUNDARY LINE	OBSERVATIONS REQUIRED
1. From Mars Hill near the source of the St. Croix River to the River St. John.	None, the line already traced to be followed.
2. Up the channel of St. John River and of the St. Francis to Lake Pohenagamook.	None.
3. In a straight line to a point on the branch of the St. John ten miles distant from the Main Branch.	None.
4. Thence to the point where the parallel of 46° 25′ latitude intersects the St. John River.	One latitude to be determined.

5. Thence up the stream along the watershed, and down Hall's Stream to the old line of boundary in 45° N. latitude.	None.
6. Thence along the line marked by Valentine and Collins to the Iroquois or St. Lawrence River.	None, the line already run to be followed.

This memorandum which was sent to Mr. Addington at the Foreign Office, was forwarded to Col. Mudge, R. E., one of the officers directing the Ordinance Survey of Great Britain, and who some years previous had been in America as commissioner connected with the same boundary. Col. Mudge had made out a programme of what he considered would be necessary in the way of astronomical work on different sections of the boundary, which was handed to Professor Airy. In referring to that section of the boundary from the source of the St. Croix River to the St. John, Col. Mudge says "This exploring line although supposed to be straight (a good approximation) was not intended to be final. It is only marked by blazing the trees at certain distances and felling such trees as came in the way." "Although the greater part is now filled up with trees, shrubs and fallen timber which must be cleared away again." "I should think that the line as explored and agreed on in Lord Ashburton's Treaty may be sufficiently made out so as to admit, supposing a good intention to exist on both sides, of the Commissioners fixing certain points at equal distances between the marked trees, which being connected by a straight line will form the boundary line from the monument to the River St. John.

From this due north line to the next point mentiond in the Treaty, it is manifest that the terms of the Treaty cannot be complied with. It is there stated that points or marks in the centre of the bed of the River St. John, such to be the boundary marks, to the second lake on the River St. Francis. Now this is altogether impracticable if the marks are intended to be at all durable. The melting of the ice in the spring would sweep away anything built on or driven into the bed of the river. The only way to carry out the intention of the Treaty will be to let the banks form the boundary with an equal right to navigation to both parties. This, I conclude (says Col. Mudge) will be finally arranged through Lord Ashburton with the American Authorities.

The boundary line would then be determined from the monument by the "due north" line to the River St. John and from thence up to the south end of the second lake on the River St. Francis, a tributary of the St. John. The straight S. W. line from Lake Pohenagamook to the N.W. branch of the River St. John — a line nearly 70 miles in length through a dense forest which was to be drawn straight so as to connect two fixed points, was a proposition which presented great difficulty and promised to be exceedingly laborious. This was a condition where Col. Mudge recognized accurate astronomical observations to determine the latitude and longitude at each of the points to be connected by a straight line; the difference of latitude and longitude of the two points to be connected would be required to compute the bearing of a line that would join them.

The astronomical observations which Col. Mudge recommended for the purpose of establishing the boundary were the following points at which he recommended latitude and longitude determinations would be advisable.

1st. The monument at the source of the St. Croix commencement of the north line.

2nd. At the termination of the north line touching the St. John River.

3rd. The southern end of Lake Pohenagamook on the St. Francis River.

4th. The point on the N. W. branch of the River St. John to be established ten miles distant from the main branch in a straight line.

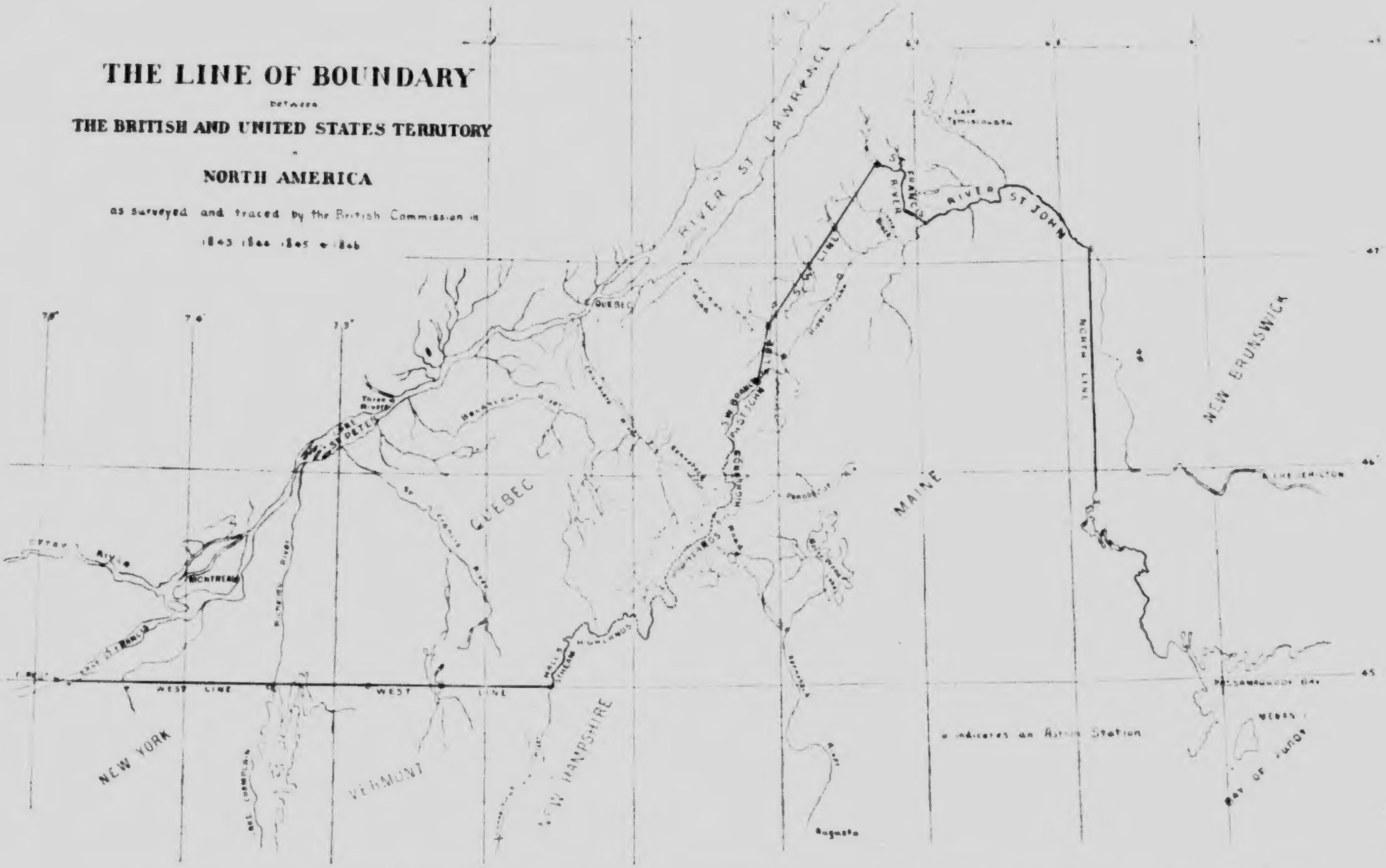
5th. The point on the S. W. branch of the St. John intersected by the parallel of 46° 25′ south, eight degrees west from the point before named on the N. W. branch.

6th. The source of the S. W. branch in the highlands and at as many other points as convenience and time of observers would admit.

For the purpose of ascertaining the difference of longitude between Lake Pohenagamook and the north west branch of the St. John River, intermediate astronomical stations were established at the mouth of the St. Francis, on the St. John River, at the rapids about half way to the N. W. branch and at the junction of the Daquamme or Metaquamme with the St. John. The astronomers, Capt. Robinson and Lieut. Pipon, Royal Engineers, occupied the stations at each terminus, and chronometers were sent back and forward in charge of members of the Engineering Corps, by canoe in summer and sleighs drawn by horses after the river froze over, repeating the journeys and comparing the time at the two points, also checking results by moon culminations and lunar distances until the officers were satisfied they had a very close approximation to the difference of longitude between Lake Pohenagamook and the astronomical station at the junction of the Daquamme with the St. John. From that point a line had been cut out and measured to the point selected under the Treaty on the N. W. branch, and with this distance and the bearing of the line the difference of latitude and longitude was computed and the data for determining the bearing of the *south-west* line complete.

The officers then took a trip out to Quebec; this was in the month of January and a road had been opened to Quebec to haul provisions in to the north-west branch. While there they had an opportunity to complete their computations and get everything in readiness to run the south-west line with large parties working from both ends.

Col. Estcourt and Capt. Robinson with a large corps of sappers and miners and laborers returned to the north-west branch the 1st of March and Lieut. Pipon with a smaller party



MAP SHOWING THE INTERNATIONAL BOUNDARY BETWEEN EASTERN CANADA AND THE UNITED STATES proceeded to Lake Pohenagamook. Both parties began work about the 1st of March. The account given of this work in a letter from Capt. Robinson written to Professor Airy will convey a very clear idea as to the *modus operandi*. The letter says in part—"I have the pleasure of informing you that we have completed the running of the line from the outlet of Lake Pohenagamook to this point. The measured distance is 64½ miles agreeing closely with the computed one, and the *error* of the course or the distance between the ends of our two lines on the ridge where we met each other was 341 feet. I feel sure we should have been nearer than this but for the circumstances of many of our observations having been made during the winter which was a severe one." "Capt. Estcourt has expressed himself as highly satisfied, but, of course, we cannot venture to take any credit to ourselves until we have your opinion. Trigonometrically done, an error of 341 feet in a side would be very great, but astronomically I hope it will pass creditably." "As soon as we had laid off the direction of the line and had cut some four miles we came to high ground, the line passing over the shoulder of Sugar Loaf Hill. From a point on this we commanded a good view over the country up to 35½ miles on the line, and by raising a platform we saw the 42½ mile point. We pitched our tents on Sugar Loaf Hill, set up the transit and directed the setting of points in the line up to the time of meeting Mr. Pipon from the opposite end." "Our mode of proceeding was as follows: —At the N.W. branch I used the altitude and azimuth instrument as a transit, setting up a meridian mark, and at the same time I used the transit for getting the correct time. The altazimuth instrument stood 35 feet east of the transit, the axis being carefully levelled, and when a circumpolar star crossed the centre wire, it was also intersected by the altazimuth instrument and a meridian mark afterwards fixed under it. This was tried and re-tried with the instrument reversed. The angle was then laid off by the altazimuth instrument and a lamp on Sugar Loaf Hill was lined in by signal and fixed under the centre wire. The transit was then moved up to the point and a good firm stand made for its reception. Every evening a large lantern with powerful burner and reflector was set up on the station where the altazimuth instrument has been placed as a back sight and which had been decided to be the boundary deflection point on the north west branch. The transit instrument was set and levelled and centred on this light, the telescope was then turned over in the direction of the line towards the next ridge or prominent point — (the cutting party having made their way through the woods during the day to the point) burnt a torch which was easily moved to the exact spot under the centre wire by flashing gun-powder. The signals were thus, one flash — are you ready? which, when answered by a flash, was an affirmative. Then we had one flash, move east, two flashes, move west, three, wait a while, four, all right, go home. Each signal was answered by a corresponding number of flashes from the other party. The flashes were made at first with a quantity equal to two charges of a fowling piece, then three charges, and at the last or greatest distance four charges. With these charges every flash could be distinctly seen, and the party could be moved almost as easily as by speaking to them. Rockets were tried for a while but many of them were never seen, and when seen they were not as good as the gun powder. The torches were made of birch bark saturated with turpentine and rosin and were distinctly visible at the greatest distance, the 42½ mile point. When the sun shone a heliostat was used for lining in. When this was visible through the last opening in the woods crossing a ridge the men could ascertain the position of the line on the ridge ahead and get the point near enough to be ready for the signals. For the first six or seven miles the line was opened out as the work proceeded, intended to be straight but this was too slow and was never sufficiently correct when within sight of the directing transit, so that system was abandoned and the party directed to go ahead from ridge to ridge as best they could with compass bearings, and on the top of each hill where the torch had been lined in, good stout poles with boards nailed across were set up as guiding points between which the sappers' theodolites could direct the cutting, the whole of the line to be cut out 30 feet wide—eight feet of which was to be cleared to the ground similarly to the north line from St. Croix to the St. John River. Mr. Pipon and I saw nothing of each other's movements until near the place of meeting, my party when making their way up a long hill about three miles from the top saw trees falling and an opening being made on the ridge apparently right in the direction they were going. To intimate to us at Sugar Loaf they had seen something satisfactory, the party on their return had an illumination with torches, and danced a hornpipe which we could see the crossing and dodging about of the lights. In determining the points on continuation of our respective lines it was found that my line was 341 feet to the northwest of the other. In correcting for this error we considered our lines to be running parallel to each other, and divided the distance 341 feet in the proportion of 42½ to 22—the distance made by each. After two flag poles had been erected on two ridges the cutting parties turned their backs on each other and returned to their respective posts altering their former marks on the several ridges proportionately to the whole error and their distance. This completed, the small transit was sent through the whole way from Lake Pohenagamook to the northwest branch working from point to point and correcting discrepancies so that we were pretty sure of its being straight from end to end."

This part of the line having presented the greater difficulty in its determination, I have taken the account—somewhat abridged—verbatim from Capt. Robinson's letter reporting the survey to Professor Airy, R.A. Professor Airy had nothing but the highest praise for this work which he declared to exceed in accuracy any thing that he had expected, and the astronomers were given great praise for their skill in achieving such satisfactory results from such data as was available to them.

In the appointment of astronomers for this work, the Foreign Office applied directly to Professor Airy, the Astronomer Royal, offering a salary of £600 per annum which would be equivalent to not less than $10,000 or $12,000 if rated at its purchasing value then in comparison with the present time. This, of course, was an inducement for good men to accept the position if offered them.

Professor Airy turned his attention to the Royal Engineers who were conducting the Ordinance Survey of Great Britain for men who had practical experience in the use of instruments of the first-class and who had been inured to camp life, as these would be better adapted for the work than young men connected with the observatories. So he wrote Col. Colby, the Superintendent of the Ordinance Survey and that officer recommended Capt. Robinson and Lieut. Pipon to be well adapted for the work if the regulations under which they served as Royal Engineers could be relaxed so as to permit of their absence from England and employment on the International Boundary Survey. Through the representations of the Earl of Aberdeen, Secretary of State, Viscount Canning, of the Foreign Office and others — the appointments were made; also a number of others belonging to the Corps of Royal Engineers were appointed to assist by taking charge of parties on the work and maintaining discipline. Professor Airy had the two astronomers at the Royal Observatory, Greenwich, acquiring practice and skill in such astronomical work as they had to undertake on the boundary, for some months before the expedition set out. J. D. Graham, Topographical Engineer of the Coast and Geodetic Survey, was the astronomer for the United States and also directed the operations of the American parties in the field. He was a very capable and painstaking observer and was said to be the first field astronomer to determine the latitude by observing the difference of the meridional zenith distances of two stars on opposite sides of the zenith, a system still considered among the most reliable and used almost exclusively in the Coast and Geodetic Survey of the United States. In determining the difference of longitude between points on the 45th parallel, the British and American astronomers worked together, a mountain was chosen which could be seen from both directions by observers stationed from 40 to 60 miles apart, and parties were sent equipped with powder, rockets and everything necessary to produce flashlights at certain pre-arranged intervals of time which could be observed simultaneously by the observers at the stations for which the difference of longitude was wanted. The results from this method proved very satisfactory.

The renewal of the boundary question arose at the time the Alaska problem was under consideration. The Treaty which arose out of that dispute not only made provision for the delimitation of the Alaska boundary which had not previously been run but for the renewal and permanent demarcation of the lines formerly run from the Atlantic to the Pacific. For the purpose of carrying out this scheme, His Britannic Majesty appointed Dr. W. F. King, C.M.G., Dominion Astronomer, the Commissioner on behalf of the British Empire, and the United States appointed Mr. O. H. Tittmann, Superintendent of the Coast and Geodetic Survey, Commissioner on behalf of the United States. This work has been in progress at different points for several years — carried out by officers under instructions from the Commissioners, the American and Canadian parties often working harmoniously together. The section east of the St. Lawrence forms one of the links in this great chain. The old lines are retraced and opened out to a width of about 30 feet or as wide as necessary for the purpose of having a clear sky line. Along the centre of the line, the brush is cleared away and such logs as would interfere with accurate measurements cut out. The lines are measured with great care where a system of triangulation cannot be carried along as a means of control in determining accurate measurements. The tapes used are *invar* which have been compared with the most reliable standards. The line is prepared for measurement by driving hubs from four to six inches in diameter and rising from three to four feet above the surface of the ground for supports for the ends of the tape. Each hub is braced by three or four braces which are driven into the ground at an angle and nailed to the centre hub near the top which holds it firmly in place. The hubs are set at an exact tape length and a strip of copper or zinc about half an inch wide and two inches in length nailed on top in the direction of the line for the purpose of marking the ends of the tape. An additional support is set for the centre of the tape when one more than 100 feet in length is used. This may consist of a stake driven in line with the end hubs and a nail driven in at the proper elevation for supporting the tape at the centre. When measuring, the tape is usually handled by four men. Thermometers are attached about one-fourth the length of the tape from each end and read by the men who attend to the marking. Two men carry levers which they connect with the rear end of the tape with a chord and at the front end to a spring balance which is attached to that end of the tape to measure the pull or stress. The tapes are usually adjusted so as to give the proper length at a temperature of 62° F. and a tension of 15 kilogrammes (about 33 lbs.). While the marker at the rear end of the tape regulates the distance until the mark at the end coincides exactly with the mark on the copper strip the marker at the fore end with a sharp brad marks that end as soon as the balance shows the proper tension and the signal "all right" is given by the other marker. Both thermometers are then read and noted and the tape carried forward to the next hub where the process is repeated until half a mile or sometimes a mile has been measured in one direction, then the same process is followed measuring back — the measurements being made in both directions.

In returning it sometimes becomes necessary to set back or forward an inch or so on the hubs that the marks at the end of the tape may always be on the zinc or copper strip. A scale of parts is carried for measuring these small distances which are entered in the notes as set back or forward as the case may be.

For the purpose of deducing the horizontal distance the difference in the elevation of each hub is taken with a spirit level then the corrections are for slope, for temperature and for distance set back or forward, also for the tape constant. Levels are also taken on cross section lines run out for half a mile on each side of the main line, as often as may be found necessary to secure data to place 20 foot contours accurately on the maps.

The line is permanently marked by carefully preserving the positions of the old monuments by means of a frame work which is erected over the spot and a nail so placed that when a plumb line is attached the plummet will hang exactly over the centre of the monument. A hole is then excavated to a depth of four feet and three feet square unless the solid rock is met with to prevent excavating to that depth. A base consisting of rock, gravel, sand and cement in proper proportions is prepared and the iron post, after being filled with cement, is replaced and carefully plumbed so that the centre is replaced as it stood originally. When the weather is favorable for cement work not more than six sacks (about 550 lbs.) are required for each monument but in the fall when it begins to freeze and the cement sets slowly two or three sacks additional are used. When owing to high hills or ridges the monuments found on the ground are not intervisible, monuments consisting of cement about twelve inches square and terminating in a point are used. These monuments are first cast in a frame and are reinforced with four iron rods one near each corner. These monuments are so set that they rise about ten inches above the base, or altogether about two feet above the ground. The base of all monuments is in the form of a pyramid rising about six inches from the four sides to the centre. These monuments are so placed that they are intervisible and at some points several monuments can be seen with a telescope in both directions.

Where the boundary is defined by the centre of a stream a system of triangulation has been carried along using the quadrilateral system so that distances are determined by two independent means and also the latitudes and departures; the level lines are run for the purpose of determining the elevations above sea level and marking the contours on the maps. For the purpose of carrying this triangulation along streams through the woods, lines had to be opened out for both the sides and diagonals of the figures so as to measure all the angles; and additional bases measured with great care at frequent intervals. At the intersections of lines, hubs, similar to those described above for chaining, were set and braced so as to be immovable, and a small flag set on top for sighting when measuring angles. When the distances did not exceed 1000 feet in length a small white peg set in the top of the hub or a four inch nail painted white would usually be sufficient. Reference monuments numbered and constructed the same as those cement monuments on the straight lines were set on both sides of the river at distances such that they will always be intervisible when the woods are cleared away and the points require to be used in defining positions on the boundary. The geographical positions, *viz.*, latitudes and longitudes, also interbearings of all these measurements, are computed, and by means of a table to be compiled, points on the boundary as laid down on the charts compiled by the former commissioners can be determined.

Along the north line from St. Croix and along the St. John River where the country is more or less cleared, the plane table was used in determining the topography and very good charts showing the locations of all the houses, fences, roads, railroads, etc., in addition to the contour lines were made.

The same condition, but to a lesser degree, held along the St. Francis River. The character of the country from Lake Pohenagamook to Hall's stream is very much the same as it was seventy years ago. In the United States the northerly part of the State of Maine belongs to private companies who preserve it as an unbroken forest for the production of lumber and timber and they cut over different parts by rotation taking only such timber as is mature. Adjoining the line in Quebec, settlement is excluded the greater part of the distance. At a few points as at Lake Pohenagamook, St. Pamphile, the Kennebec Road and probably two or three others east of Hall's stream a road has been made to the boundary and settled, but by far the greater portion is inaccessible from any settlement and the timber under limit which does not call for any speedy removal — so the wilderness remains. That part of Canada is subject to quite a heavy precipitation. During the winter the snow usually falls to a depth of from three to four feet, covering the ground from November until the month of May, and the summer months are usually noted for abundance of rain, so the forest fires do not make such headway in denuding the forests here that they do in many other parts of Canada where moisture is absent and the precipitation less. The owners of the land in the United States keep bush rangers or fire guardians who travel the country over and are on the look out for any fires which may be accidentally started by lightning or otherwise and to extinguish them or secure such assistance as may be available to keep the fire from spreading, so that in many parts of the country there are no evidences of it being overrun by fire since the line was run out seventy years ago.

OTTAWA, CANADA,
April, 1913.